

The Saliency of Small: Nanotechnology Coverage in the American Press, 1986-2004

Paper submitted to the International Communication Association

for conference

26-30 May 2005

Submitted by

Bruce V. Lewenstein*

Jason Gorss

Joanna Radin

*** Corresponding author:**

321 Kennedy Hall

Cornell University

Ithaca, NY 14853

b.lewenstein@cornell.edu

The Salience of Small: Nanotechnology Coverage in the American Press, 1986-2004

Abstract

Recent studies of media coverage of biotechnology have suggested that such coverage was similar to coverage of nuclear energy and other "emerging technologies." To move beyond individual cases and towards a broader theory of media coverage of emerging technologies, this study looks at a new emerging technology – nanotechnology – and explicitly compares coverage of it to coverage of earlier emerging technologies. We present a preliminary content analysis of nanotechnology coverage in the New York Times, Washington Post, Wall Street Journal, and Associated Press for the period 1 January 1986 to 30 June 2004. Media attention to nanotechnology seems to parallel coverage of biotechnology in its early stages of issue development—starting out low and rising sharply as it spreads from “elite” media outlets to more general outlets. As with biotechnology, coverage of nanotechnology throughout this period is overwhelmingly positive, focusing on progress and potential economic benefits, and with little discussion of attendant risks. Nanotechnology coverage does, however, focus more on risks from the outset than biotechnology did, suggesting that issues of public accountability are growing more salient to journalists. We conclude with comments about the possibility of a theory of media coverage of emerging technologies.

The Saliency of Small: Nanotechnology Coverage in the American Press, 1986-2004

Nanotechnology is the science of the very small, involving manipulation of atoms at the scale of a nanometer—one billionth of a meter, or about 80,000 times smaller than the width of a human hair. The field has been framed by some as the next industrial revolution, with the promise of producing lighter and stronger materials, energy-efficient manufacturing, advances in medical monitoring and bioremediation, much more powerful computers, and many others.

As a public issue, nanotechnology is still in its infancy. Indeed, initial surveys show that most people haven't even heard of "nano," let alone formed opinions about it (Royal Academy, 2004; Cobb and Macoubrie, 2004; Scheufele and Lewenstein, 2004). But many other levels of society—including businesspeople, politicians, and academics—are paying close attention to the development of this new scientific field.

Scientists—especially chemists—have been doing work at the nano level for years. A recent search of *Science Citation Index* found that 1,490 scientific articles dealing with nanoscience and nanotechnology were published between 1982 and February 2004 (Stephens, 2004). The number of publications is rising steadily, starting with one in 1987 and increasing to 497 in 2003. Several scientific journals devoted specifically to nanotechnology have sprung up in recent years, including *Nanotechnology*, the *Journal of Nanoparticle Research*, and *Nano Letters*.

The U.S. federal government is also making nanotechnology a priority, investing heavily in new research because of its potential for improving both the welfare and the standing of the country. Funding for nanotechnology research and development in the United States has increased sixfold, from \$116 million in 1997 to an estimated \$961 million in 2004, and President

Bush's 2005 budget request calls for a total of \$982 million for the National Nanotechnology Initiative.

The business community is also investing in nanotechnology, with new companies sprouting up today like Internet and biotechnology companies did in the 1980s and 1990s. Many are eagerly jumping on the bandwagon and applying nano to their name, even if the moniker is not quite accurate. The National Science Foundation predicts that nanotechnology could become a \$1 trillion global market by 2015, with the potential for staggering advances in pharmaceuticals, semiconductors, optics, and environmental remediation, to name but a few.

Of course, along with all of this "revolutionary rhetoric" come voices of caution and dissent. A number of interested actors are speaking up about the potential negative side of nanotechnology. Concerns revolve around a number of topics: lab safety while working with nanoparticles; privacy issues, including the potential for invasive monitoring with "nanocameras"; political questions about where funding should go and who will benefit from potential technologies; and the various environmental effects of nanoparticles. In January 2003, for example, the Canadian ETC Group warned that nanotechnology is moving too fast without the proper studies of possible risks, suggesting a moratorium on research into molecular manufacturing. This same organization was instrumental in turning European public opinion against "Frankenfoods."

The issue is also slowly working its way into the popular media. In 2000, Bill Joy, senior scientist at Sun Microsystems, wrote a widely cited article for *Wired* magazine suggesting that "the future doesn't need us," and questioning whether society is able to handle the implications of continuing development in robotics, genetic engineering, and nanotechnology (Joy, 2000). A major story in the *Washington Post* introduced many to the environmental implications of

nanotechnology for the first time (Weiss, 2004). Michael Crichton's most recent sci-fi novel, *Prey*, is a story of self-replicating nanobots run wild (Crichton, 2002). Nanotechnology has even made its way to the big screen, with cameo appearances in *Spiderman 2*, *The Hulk*, and *Terminator 3*.

And in a sure sign that nanotechnology is beginning to seep into the public consciousness, an article recently appeared on *Salon.com* detailing how Rabbi Yehuda Berg, Madonna's personal guide into Jewish mysticism, sees incredible similarities between Kabbalah and nanotechnology. Part of the article picks up on a key theme in the discourse about nanotechnology:

The mantra in the nanotech industry is to learn from the mistakes made in biotechnology and the public rejection of genetically modified organisms. Partly to blame was a "top-down" attitude taken by a scientific establishment that was much too self-important to bother with public attitudes and perceptions. So, consideration of "societal and ethical implications" is No. 1 on the nanotech industry's list. (Lovy, 2004)

Scientists are increasingly realizing that the vast promise of new technologies like nanotechnology does not press forward in a vacuum, and that the public needs to be engaged "upstream" in development to discuss the challenges and opportunities presented by new technologies. From the scientists' perspective, engagement can help prevent the type of backlash that occurred with nuclear power and genetically modified (GM) food. Scientists and policymakers need to consider *implications*, not just *applications*. From the public's perspective, engagement is a tool for the exercise of democratic power, for using its ability to shape the development and use of new technologies (Dickson 2001, Anon 2003, Leshner 2003).

At an October 2004 workshop for journalists about nanotechnology sponsored by the Kavli Institute at Cornell University, Curt Suplee, director of the Office of Legislative and Public Affairs for the National Science Foundation and former *Washington Post* science reporter, compared nanotechnology to climate change (Suplee, 2004). Suplee suggested that reporters got it wrong on climate change, using a “he said/she said” approach to covering the issue, rather than demonstrating the true weight of scientific consensus. This criticism has been leveled against science reporting in general by several communication scholars (Dearing, 1995; Stocking, 1999).

In Suplee’s view, reporting about nanotechnology is heading down this same road. But despite the various elements of public discussion listed above, the issue of nanotechnology has not been framed in a definitive way, so the public is still essentially a “blank slate.” He suggested that reporters, academics, scientists, and institutions have the opportunity to do nanotechnology right, right from the start.

Theoretical Foundations

Nanotechnology could arguably be viewed as the next link in a long chain of “emerging technologies”—a list that includes information technology, biotechnology, nuclear power, and others. Such technologies are usually discussed in terms of specific examples, such as pollution-eating nanobots and under-skin chips that carry personalized medical information.

But Hilgartner and Lewenstein (2004) suggest that rather than simply viewing them as a collection of specific cases, much can be gained by seeing them as a general phenomenon. “From this perspective, what is most striking is that ‘emerging technologies’ have become a distinctive social world, a peculiar ‘speculative space’ found at the edges of technological systems, where innovations are being most actively constructed and transformed” (p. 1). In this dynamic space, emerging technologies are surrounded by their own culture, including various “speculators” making claims of promise or peril.

In public discourse, the notion of emerging technologies conveys unmistakable connotations of revolutionary potential. This “revolutionary rhetoric” often leads to visible controversy, and to compound matters, “many issues involving emerging technologies are hashed out under the glare of media spotlights.”

Technological accidents such as the devastating 1984 chemical factory disaster in Bhopal, India, that killed thousands or the highly visible recent failure of the Columbia space shuttle can expose the hidden messiness of technological systems and the organizations responsible for managing them. Thus, it is no wonder that struggles to control the public display of information often develop. (Hilgartner and Lewenstein, 2004, p. 6)

The concept of “revolution” is thoroughly overused and ill-defined in general discourse, as is its sister term, “paradigm.” The reliability of this “revolutionary rhetoric” is not always clear, but when the discourse takes place under the “glare of media spotlights,” it illuminates the distinctive space in which an emerging technology operates, and thus provides an opportunity to scrutinize the process and its various actors.

The mass media play an important role in issues that affect policy, providing the primary arena for debate among scientists, policymakers, industry, and other political and social interests. Not only do the media focus the attention of competing actors and the general public, but the media also shape how policy issues are defined and symbolized (Nisbet and Lewenstein, 2002).

How media coverage of an issue affects public opinion is highly complex and contested, but a classic description suggests that the media “may not be successful much of the time in telling people what to think, but it is stunningly successful in telling [people] what to think *about*” (Cohen, 1963). This “agenda-setting” role of the media has been demonstrated in a range of emerging technologies, most recently biotechnology (Nisbet and Lewenstein, 2002). In the early stages of development, the mass media can be a major source of people’s ideas about a new technology. Thus it is important to gauge how various media outlets are treating nanotechnology, in an attempt to understand the overall climate surrounding the issue.

This study focuses on nanotechnology coverage in the American media to gain a preliminary understanding of two particular dimensions of how the media represent the issue: salience and framing. Salience is an indicator of the attention given to an issue, while framing shows what types of arguments are being mobilized. As these change over time, they demarcate phases in the life history of the debate (Gaskell and Bauer, 2001).

More broadly, the goal is to see if media coverage and public opinion surrounding emerging technologies follows a characteristic pattern. According to Hilgartner and Lewenstein (2004), “Much work needs to be done to systematically map the contours, dynamics, and topology of the social, political, and technical features that constitute the speculative space of ‘emerging technologies’” (p. 6). This research is one small step in that direction.

Several others have studied examples of emerging technologies in the public sphere, most notably related to nuclear power and biotechnology (Gamson and Modigliani, 1989; Gaskell and Bauer, 2001; Nisbet and Lewenstein, 2002; Ten Eyck and Williment, 2003; McNerny et al., 2004). Gamson and Modigliani analyzed discourse on nuclear power from 1945 to 1989 in four general audience media: television news coverage, newsmagazine accounts, editorial cartoons, and syndicated opinion columns. When the discourse was compared with public opinion surveys, they found that public opinion about nuclear power could only be understood by rooting it in an issue culture that was both *reflected* and *shaped* by the media. This classic study formed the basis for several research projects analyzing media discourse and public opinion on biotechnology in the latter part of the 20th century.

The most obvious comparison for the current study is Nisbet and Lewenstein’s analysis of biotechnology in the American elite press from 1970 to 1999. They found that media attention in the *New York Times* and *Newsweek* steadily increased across the 1980s and most of the 1990s, although it was significantly event-driven, peaking and plummeting in response to major occurrences in the scientific realm. The tone of this coverage was consistently positive, with overwhelming emphasis on the frames of scientific progress and economic prospect.

Using these earlier studies as reference points, the goal of the current research is to move beyond individual cases and begin to characterize the general category of emerging technologies.

Hypotheses

Nisbet and Lewenstein (2002) chose to base their biotechnology study on a set of narrowly defined research questions rather than hypothesizing specific media trends, because of the limited availability of previous quantitative research characterizing the nature of media coverage of biotechnology. But since we are suggesting that nanotechnology may follow a similar trajectory as biotechnology and other emerging technologies, we should have a basis for hypothesizing. The general hypothesis guiding this study is that media coverage and public opinion surrounding emerging technologies follows a regular pattern, and specifically that media coverage of nanotechnology will follow the same basic trajectory, in terms of salience and framing, as did biotechnology before it.

More detailed hypotheses can also be formulated based on the findings from earlier studies of biotechnology coverage, particularly in the United States:

Hypothesis 1: Coverage will start out very low and then rise steadily when triggered by certain “framing events” in the scientific and public spheres.

Hypothesis 2: In the early stages of development, coverage will be overwhelmingly positive, with most stories focusing on progress and economic prospects.

Hypothesis 3: As time passes and nanotechnology seeps into the public consciousness, coverage will spread from elite media outlets to more general media outlets.

Methods

To assess the place of nanotechnology in the media, we conducted a content analysis of three “elite” media outlets (*New York Times*, *Washington Post*, *Wall Street Journal*) and one general media outlet (*Associated Press*) for the period 1 January 1986 to 30 June 2004. The final sample contained about 600 relevant articles, drawn from a pool of all articles that contained the words “nanotechnology” or “nanoscience” in the Lexis-Nexis online database (for the *New York Times*, the *Washington Post*, and the *Associated Press*) or the Factiva online database (for the *Wall Street Journal*). For the period 1 Jan 1986 to 30 Jun 2003, we drew a sample of half the total population of relevant articles, resulting in 375 articles from this period. For the period 1 Jul 2003 to 30 Jun 2004, we coded the entire population of 245 relevant articles. The coding sheet was based on the coding sheet used in Nisbet and Lewenstein (2002), with changes made after exploratory coding. After training resulting in intercoder reliability of more than 75% for all items, coding was performed in waves by two graduate students and one undergraduate.

We chose to include elite media outlets because coverage in opinion-leading publications like these is likely to represent the prevailing tone of coverage in the United States. As Gitlin (1980) has observed, stories tend to spread vertically within the news hierarchy, with editors at regional news outlets often deferring to elite newspapers and newswires to set the national news agenda. These papers also set the science agenda because they often have much larger and more experienced science reporting staffs. And since nanotechnology is a science-related issue in its early stages of development, discourse is still most likely to take place among various elites. Studies have shown that, traditionally, leaders in America—whatever their specific discipline—focus their attention mainly on the *New York Times*, the *Wall Street Journal*, and the *Washington Post* (Weiss, 1974). Although the balance among these particular publications and newer media

like all-news channels and the Web have changed in recent years, no clear analyses have emerged.

The *Associated Press* was also chosen to include a more general media outlet in the study, and print was chosen over television or radio because it is more amenable to content analysis, but also because there is some evidence that print media set the agenda for other types of news outlets (Lopez-Escobar et al., 1998; Roberts & McCombs, 1994).

The analytical approach laid out by Gamson and Modigliani (1989) and refined by Gaskell and Bauer (2001) and Nisbet and Lewenstein (2002) was adapted for our study, with some slight modifications. The approach involves identifying key “themes” in the media coverage, as well as “frames” in the articles. The concept of “frame” plays on the image of a picture that is defined at the edges, putting a drawing or a photograph into a defined context. The meaning of the picture depends on the context that is opened up by the frame. By analogy, a news story on a certain theme is presented within a particular frame of discourse that puts the topic in a particular light and perspective (Gaskell and Bauer, 2001, p. 40). These media frames offer a central organizing idea or story line that provide meaning to an unfolding series of events, suggesting what the controversy is about, and the essence of an issue (Gamson and Modigliani, 1989). When an issue does appear in the media, if interests can define their stand as well as the alternatives available for discussion, then they have “framed” the situation in more winnable terms, delimiting the arguments the opposition can make and screening them off from participation (Berkowitz, 1992). Frames also serve as working routines for journalists that allow journalists to quickly identify and classify information, packaging it for audiences. These organizing devices are especially useful when journalists are thrust into unfamiliar territory.

Framing strategies, however, can lead to “pack journalism,” with journalists adopting similar frames across coverage (Gitlin, 1980).

As we adapted the framing typology, two of the frames associated with biotechnology—globalization and nature/nurture—are not especially pertinent to nanotechnology, so they were excluded from the coding. Likewise, a preliminary analysis revealed two new frames, especially the idea that applications of nanotechnology will not appear for years into the future (“They’re a long way away”) and that nanotechnology is part of a confluence of emerging technologies including biotechnology and artificial intelligence (Table 1).

Results

The basic trajectory of coverage shows that media attention to nanotechnology began in 1998, rising quickly from just a few articles a year to more than 150 in 2003 (Figure 1: The apparent dip in 2004 is an artifact of having data for only half the year; the total will probably far surpass the 2003 total). This trajectory follows the same pattern as biotechnology did in its early stages of issue development.

Figure 2 shows coverage of biotechnology in the *New York Times* plotted with nanotechnology coverage in the same newspaper. (The *New York Times* was the only common publication between the two studies.) Year 1 for biotechnology corresponds to 1970; for nanotechnology, year 1 is 1986. The comparison is somewhat artificial, since these are just the starting dates for both content analyses, but the graph shows that the amount of coverage in the early years is very similar for both emerging technologies.

A somewhat more meaningful comparison appears in Figure 3, which shifts nanotechnology coverage two years to the left so that the first spike in coverage for both issues occurs at the same time: year 8. This graph reveals that the first spike engendered almost exactly the same number of articles in the *New York Times*. Figure 3 also shows that nanotechnology coverage has reached the same level as bio did at about this time—16 years into the study. The first major spike in biotechnology coverage occurred in year 11, producing almost 40 articles on the subject. Nanotechnology's first major spike occurs a little later in year 13, producing about 25 articles. Since events in the scientific realm and the public sphere rarely (if ever) follow a predictable pattern, there is no reason to expect nanotechnology will follow the same exact cycle as biotechnology. But taken together, these data suggest that nanotechnology coverage is event-driven, rather than issue-driven

Across each of the four publications, coverage has generally increased steadily over time (Figure 4). Two main exceptions occur: The number of articles in the *New York Times* seems low for 2004, while *Associated Press* coverage does not really appear until 2000 and then rises very quickly in 2003 and 2004, far surpassing the other publications. (Since data was only available for the first half of 2004, it has been doubled for this graph to illustrate the projected value for the full year.) The explanation for the lower number of *New York Times* articles is unclear. The large jump in *Associated Press* coverage, however, seems to indicate that interest in nanotechnology is spreading to a wider public beyond the audience of the elite press.

Coverage throughout the entire period is overwhelmingly positive, with emphasis on applications and the economic potential of nanotechnology (Figure 5). As with coverage of biotechnology, most stories could be classified into a relatively small set of themes: applications, policy (current legislation), politics (bipartisan support/disagreement), financial, and risks. Other unanticipated categories arose, including science fiction scenarios (especially in 2002, with coverage of Michael Crichton's novel *Prey*).

Figures 5 and 6 show the number of stories exhibiting positive and negative assessments by theme. Articles about applications and finance dominate the coverage, and, as would be expected, these tend to be more positive in tone. Articles about risks associated with nanotechnology are clearly negative in tone, but such articles are still a small part of the overall mix. The key observation from these data is that positive stories tend to be much more strongly positive than the negative stories are negative. This demonstrates further how overwhelmingly positive the coverage is in general. Again, these tendencies roughly parallel the positive and negative assessments of biotechnology seen in earlier coverage.

Irrespective of the year, the vast majority of articles tend to frame nanotechnology in terms of progress and economic prospects (Figure 7: The frames have been weighted to a percentage scale based only on the dominant frame in each story. More than one frame could actually appear in a given story). The “public accountability” frame arises fairly early and remains present throughout. “Long way away” appears in 2000 and 2001, but then does not show up again as a dominant frame, which may suggest that as researchers continually present more findings based on nanotechnology, these technologies do not seem as far away as they once did. Interestingly, “runaway” and “Pandora’s Box” do not appear until 2002 and 2003, corresponding with the release of Michael Crichton’s *Prey* in 2002 and the ETC Group’s report in early 2003, which both focused on the uncontrollable nature of nanotechnology. These frames were not been dominant in any stories during the first part of 2004, which would suggest that the effect of these publications might be dissipating. This would further support the notion that nanotechnology coverage is event-driven.

Figures 9 and 10 show the number of stories exhibiting positive and negative assessments by frame. As with the themes, articles about applications and finance dominate the coverage, and are much more positive in tone. Negative assessments show up significantly only with “runaway” and “Pandora’s Box,” as would be expected. But as Figure 9 demonstrates, these can also be framed in a positive manner. Again, the positive assessments are much more positive than the negative assessments, suggesting a media perception of nanotechnology as a distinctive new source of progress.

Figure 11 plots the percentage of articles in the *New York Times* with a given frame for nanotechnology and for the first 20 years of the biotechnology data. (Since the nanotechnology framing data is ordinal, the bars represent the percentage of articles that include a frame as either

“present” or “dominant.”) Both technologies are framed in terms of progress, but this frame is more dominant in biotechnology coverage, and the other more “negative” frames barely appear at all. Yet the nanotechnology stories include “Pandora’s Box,” “runaway,” and “public accountability” as a significant percentage. The explanation for this phenomenon is not clear, but perhaps the experience with biotechnology has caused journalists to be a little more skeptical about nanotechnology from the outset.

Discussion

Hypothesis 1 was tentatively confirmed, with nanotechnology coverage starting out very low until the late 1990s when the number of articles took a dramatic leap. What were the events that spurred this rise in coverage? Further research should examine this connection more rigorously, but the anecdotal evidence suggests that popularized accounts like Bill Joy's article in *Wired* and Michael Crichton's *Prey* may have had a dramatic effect on the *amount* of coverage, but not on the *tone* of coverage. Journalists seemed to focus more on the revolutionary potential of nanotechnology as a force for economic and technological progress. The so-called "*Prey* effect," however, may not have played much of a part in the coverage at all. Prior to analyzing the data, we suspected that *Prey* might cause a bump in coverage that would eventually die down in 2003 and 2004, but this does not appear to have been the case. The number of articles about nanotechnology continues to rise rapidly.

The data also seem to support Hypothesis 2. The coverage of nanotechnology is overwhelmingly positive in general; and even when stories are negative, they are not strongly negative. When compared to biotechnology, however, the coverage is not quite as overwhelmingly positive as biotechnology was in its first 20 years. With biotechnology, the more negative frames barely appear during this period, while the coverage of nanotechnology includes them at a more significant level. Further studies should examine the reason for this difference: Is it an inherent aspect of nanotechnology as an issue? Or is it an effect of the current climate in the United States and around the world—partly influenced by biotechnology controversies—where people are more inclined to pay attention to risks, whether they come from terrorism or technology?

Hypothesis 3 seems to be supported, as the number of stories about nanotechnology in the *Associated Press* has increased rapidly and even eclipsed all of the other elite media outlets. This tentatively suggests that the issue is becoming more salient to the general public, but questions remain. Are the journalists at the *Associated Press* just following the lead of the elite media? Or are they reflecting a growing interest by the general public in nano-related issues? These and other questions should be addressed in future studies.

Two other interesting bits of information came out of the study. First, the “public accountability” frame appears surprisingly early in nanotechnology coverage and remains a significant element throughout. This frame appears more often than the “runaway frame” and on a par with the “Pandora’s Box” frame—both of which encompass the scary “sci-fi” scenarios that nanotechnology could engender. This suggests that the media may be reflecting what risk communication scholars have known for years: what really worries people are not scary “sci-fi” scenarios, but rather questions of trust and credibility, especially regarding public officials and multinational corporations (Friedman, et al. 1999; Irwin and Wynne 1996).

Conclusion

The current study is just a preliminary analysis, but the data seem to point to a similar pattern of media coverage for biotechnology and for nanotechnology—in terms of both salience and framing. There is, of course, no reason to expect that coverage of the two issues will be exactly the same, but perhaps some of the lessons from biotechnology can be applied to nanotechnology, while also providing a foundation to begin understanding a new and distinct theoretical category: “emerging technologies.”

More broadly, there are three questions we seek to address regarding nanotechnology and emerging technologies in general: 1) What is the pattern of media coverage? 2) What shapes this media coverage? 3) What are the effects of this media coverage?

Clearly, this research needs to be coupled with studies of public opinion in order to understand the linkages between the public presence of information and the actual public debate that occurs. Three recent studies (Royal Academy, 2004; Cobb and Macoubrie, 2004; Scheufele and Lewenstein 2004) reveal one common theme: The majority of people have very little knowledge about nanotechnology, but they still seem to view it in a positive light. Could this be an effect of the overwhelmingly positive media coverage to date? Perhaps, but it could also be that people lump nanotechnology into the general category of “science and technology”—a category that most in the United States tend to support, saying the potential benefits outweigh the risks (National Science Board, 2004, p. 7-23).

Cobb and Macoubrie (2004) point out an interesting trend from their study: Being exposed to *Prey* significantly affects respondents’ perceptions of risks versus benefits, but not in the expected direction. “A whopping 63% predicted that benefits of nanotechnology would exceed the risks if they were exposed to *Prey*, compared to just 38% if they weren’t exposed to

it” (p. 11). It has been suggested that this effect stems from the fact that most people who read sci-fi books like *Prey* already have a positive view of science and technology, although Cobb and Macoubrie say this can be ruled out because there are hundreds more respondents who like science fiction but have not been exposed to *Prey*. Another possible explanation is that humanity eventually triumphs at the end of the book, painting scientists and science in a more positive light.

Future research could also investigate how media coverage affects other public arenas, such as the direction of government funding and corporate investment, and even the polling agenda itself (Dearing, 1989).

To understand media coverage and its effects more fully, we need, as David Edge suggests, “a more detailed understanding not only of the topography of the public’s image of science but also of how (and to what extent) that image can be manipulated by those in whose interest it is to do so” (Edge, 1995). To understand what shapes media coverage of an emerging technology, further studies could attempt to correlate specific events with peaks in coverage and shifts in tone, while also examining the “agenda-building” activities of various actors in the public sphere. According to Nisbet and Lewenstein (2002), “Recognizing the importance of media coverage in influencing policy outcomes, various competing interests or political actors often lobby the media to shape the attention and emphasis of coverage in a way that marshals support for their positions” (p. 362.) Several studies of this nature have already been conducted for biotechnology-related issues (Nisbet and Lewenstein, 2002; Ten Eyck and Williment, 2003; McInerney et al., 2004; Nisbet et al., 2003).

Once an issue is framed by the media, it can be very difficult for actors in the public sphere to shift the image to another perspective. This was clearly illustrated in the debate over

GM food. Yet the preliminary public opinion data about nanotechnology, coupled with anecdotal evidence, suggests that the framing for nanotechnology is yet to be established. What will this framing event be, since it does not seem to have been the release of *Prey*?

Nisbet et al. (2003) found that media attention to stem cell research peaked when the issue was most easily dramatized, and that the potential for drama was maximized when the issue shifted from administrative policy contexts to overtly political policy arenas such as Congress and the Presidency, where elevated levels of agenda-building are more likely to occur. Here, stories can be reported using familiar storytelling themes and formats, including matters of political controversy and ethics/morality. McComas and Shanahan (1999) suggested a similar connection in their analysis of climate change stories in the *New York Times* and the *Washington Post* between 1980 and 1995. Media attention to global warming was cyclical, and the authors suggest that the ability of journalists to construct narratives influenced these attention cycles.

This notion is fairly intuitive; journalists are always looking for “the story.” But it also fits with a strand of communication theory first presented in detail by Walter Fisher. Narrative Paradigm Theory (Fisher, 1987) suggests that humans are essentially “storytelling animals,” and therefore narratives subsume all other forms of communication. Rationality is determined by the nature of persons as narrative beings—their inherent awareness of *narrative probability*, what constitutes a coherent story, and their constant habit of testing *narrative fidelity*, whether the stories they experience ring true with the stories they know to be true in their lives. In short, the way humans make their decisions is through stories that offer “good reasons” to act one way or the other. The logic of good reasons is the method of determining a good story, based essentially on the criteria of narrative probability and narrative fidelity. Future research should examine how narratives play a role in shaping issue-attention cycles related to emerging technologies.

References

- Berkowitz, D. (1992). Who sets the media agenda? The ability of policymakers to determine news decisions. In Kennamer, J.D. (ed.) *Public opinion, the press, and public policy* (81-102). Westport, CT: Praeger.
- Bauer, M. W. and Gaskell, G. Eds. (2002). *Biotechnology: The Making of a Global Controversy*. Cambridge, U.K.: Cambridge University Press.
- Cobb, M. and Macoubrie, J. (2004). Public perceptions about nanotechnology: Risks, benefits, and trust. *Journal of Nanoparticle Research* (in press).
- Cohen, B. (1963). *The Press and Foreign Policy*. Princeton: Princeton Univ. Press.
- Crichton, M. (2002). *Prey*. New York: Harpercollins.
- Dearing, J. W. (1989). Setting the polling agenda for the issue of AIDS. *Public Opinion Quarterly* 53, 309-329.
- Dearing, J. W. (1995). Newspaper coverage of maverick science: Creating controversy through balancing. *Public Understanding of Science*, 4, 341-361.
- Durant, J., Bauer, M., and Gaskell, G., eds. (1998). *Biotechnology in the public sphere: A European source book*. London: Science Museum.
- Edge, D. (1995). Reinventing the Wheel. *Handbook of Science & Technology Studies* (p. 3-23). S. Jasanoff, Markle, G., Petersen, J. C., and Pinch, T. J. (eds.). Thousand Oaks, Calif.: Sage.
- Fisher, W. R. (1987). *Human Communication as Narration: Toward a Philosophy of Reason, Value, and Action*. Columbia, SC: University of South Carolina Press.

- Gamson, W.A., & Modigliani, A. (1989). Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach. *American Journal of Sociology*, 95, 1-37.
- Gaskell, G. and Bauer, M.W. Eds. (2001). *Biotechnology 1996-2000: The Years of Controversy*. London: Science Museum.
- Gitlin, T. (1980). *The whole world is watching: Mass media in the making and unmaking of the new left*. Berkeley: University of California Press.
- Hilgartner, S. and Lewenstein, B. (2004). The speculative world of emerging technologies. Unpublished manuscript.
- Joy, B. (2000, March). Why the Future Doesn't Need Us. *Wired*, 8.
- Lewenstein, B., Radin J., et al. (2004). Nanotechnology in the media: A preliminary analysis. *Societal Implications of Nanoscience and Nanotechnology II: Maximizing Human Benefit*. (Report of the National Nanotechnology Initiative Workshop, December 3-5, 2004, Arlington, VA). M. C. Roco and W. S. Bainbridge. Washington, DC: National Science Foundation (in press).
- Lopez-Escobar, E., Llamas, J. P., McCombs, M., & Lennon, F. R. (1998). Two levels of agenda setting among advertising and news in the 1995 Spanish elections. *Political Communication*, 15(2), 225-238.
- Lovy, H. (2004, October 7). Nanotech Angels. *Salon.com*. Accessed at <http://www.salon.com/tech/feature/2004/10/07/nanokabbalah/index.html>
- McComas, K. & Shanahan, J. (1999). Telling Stories About Global Climate Change: Measuring the Impact of Narratives on Issue Cycles. *Communication Research* 26(1): 30-57.

- McInerney, C., Bird, N., and Nucci, M. (2004). The Flow of Scientific Knowledge from Lab to the Lay Public: The Case of Genetically Modified Food. *Science Communication* 26(1): 44-74.
- National Science Board. (2004). Science and Technology: Public Attitudes and Understanding. In *Science & Engineering Indicators--2004*. Washington, D.C.: U.S. Government Printing Office. (Ch. 7).
- Nisbet, M. and Lewenstein, B. (2002). Biotechnology and the American Media: The Policy Process and the Elite Press, 1970 to 1999. *Science Communication* 23(4): 359-391.
- Nisbet, M.C., Brossard, D., & Kroepsch, A. (2003). Framing science: The stem cell controversy in an age of press/politics. *Harvard International Journal of Press/Politics* 8(2), 36-70.
- Radin, J. 2003. *Scientists in Government: Framing the Environmental and Societal Implications of Nanotechnology*. Master's thesis, Communication, Cornell University, Ithaca, NY.
- Roberts, M., & McCombs, M. (1994). Agenda setting power of political advertising: Origins of the news agenda. *Political Communication*, 11(3), 249-262.
- Royal Academy of Engineering and Royal Society (2004). *Nanoscience and nanotechnologies: opportunities and uncertainties*. London.
- Stephens, L. F. (2004). News Narratives About Nano: How Journalists and the News Media Are Framing Nanoscience and Nanotechnology Initiatives and Issues. Presented at *Imaging and Imagining Nanoscience & Engineering*, University of South Carolina, Columbia, SC, March 4-7, 2004.
- Stocking, S. H. (1999). How Journalists Deal With Scientific Uncertainty. In Friedman, S.M., Dunwoody, S., & Rogers, C.L. (eds.) *Communicating Uncertainty: Media Coverage of New and Controversial Science* (pp. 3-21). Mahwah, NJ: Lawrence Erlbaum Associates.

Suplee, C. (2004, October 5). Roles of Academia and Media in Shaping Public Understanding of Nanoscale Science. "Nanoscale Science under the Microscope: A Journalist's Workshop in Nanotechnology." Workshop web site:

<http://www.research.cornell.edu/kic/workshop/index.html>

Ten Eyck, T. A., and Williment, M. (2003). The National Media and Things Genetic: Coverage in the *New York Times* (1971-2001) and the *Washington Post* (1977-2001). *Science Communication*, 25(2): 129-152.

Weiss, C. (1974). What America's Leaders Read. *Public Opinion Quarterly* 37(1): 1-22.

Weiss, R. (2004, February 1). For Science, Nanotech Poses Big Unknowns. *Washington Post*, A01.

Table 1. A Framing Typology for Nanotechnology

Progress: report of technical development; nanotechnology represents the “wave of the future.”

Economic Prospects: nanotechnology’s effect on the economy.

Ethical: nanotechnology is either morally necessary or morally repugnant.

Pandora’s Box: developing nanotechnology will create unforeseen ills.

Runaway: nanotechnology may spiral out of human control.

Public Accountability: coverage about ethical, legal, and societal implications; influence over research and development.

Long Way Away: applications from nanotechnology will be in the distant future.

Confluence: nanotechnology represents a confluence of technologies including biotechnology, information technology, and cognitive science.

NOTE: Framing typology is adapted from Nisbet and Lewenstein (2002) and Durant, Bauer, and Gaskell (1998), and was originally developed in part by Gamson and Modigliani(1989).

Figure 1. Total media stories about nanotechnology in the *New York Times*, *Wall Street Journal*, *Washington Post*, and Associated Press, 1986-2004.

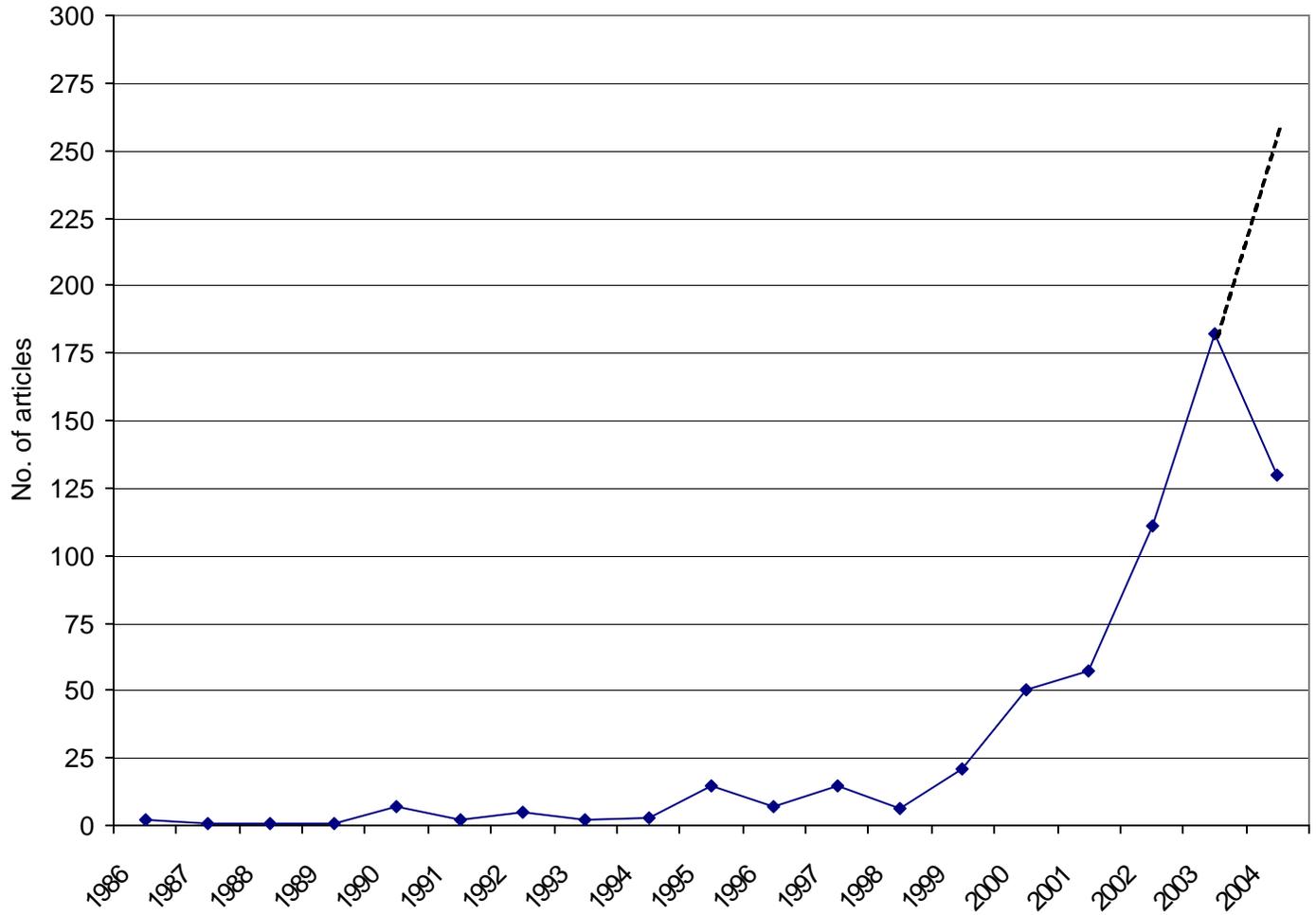


Figure 2. Comparison of biotechnology and nanotechnology coverage in the *New York Times* from common starting year.

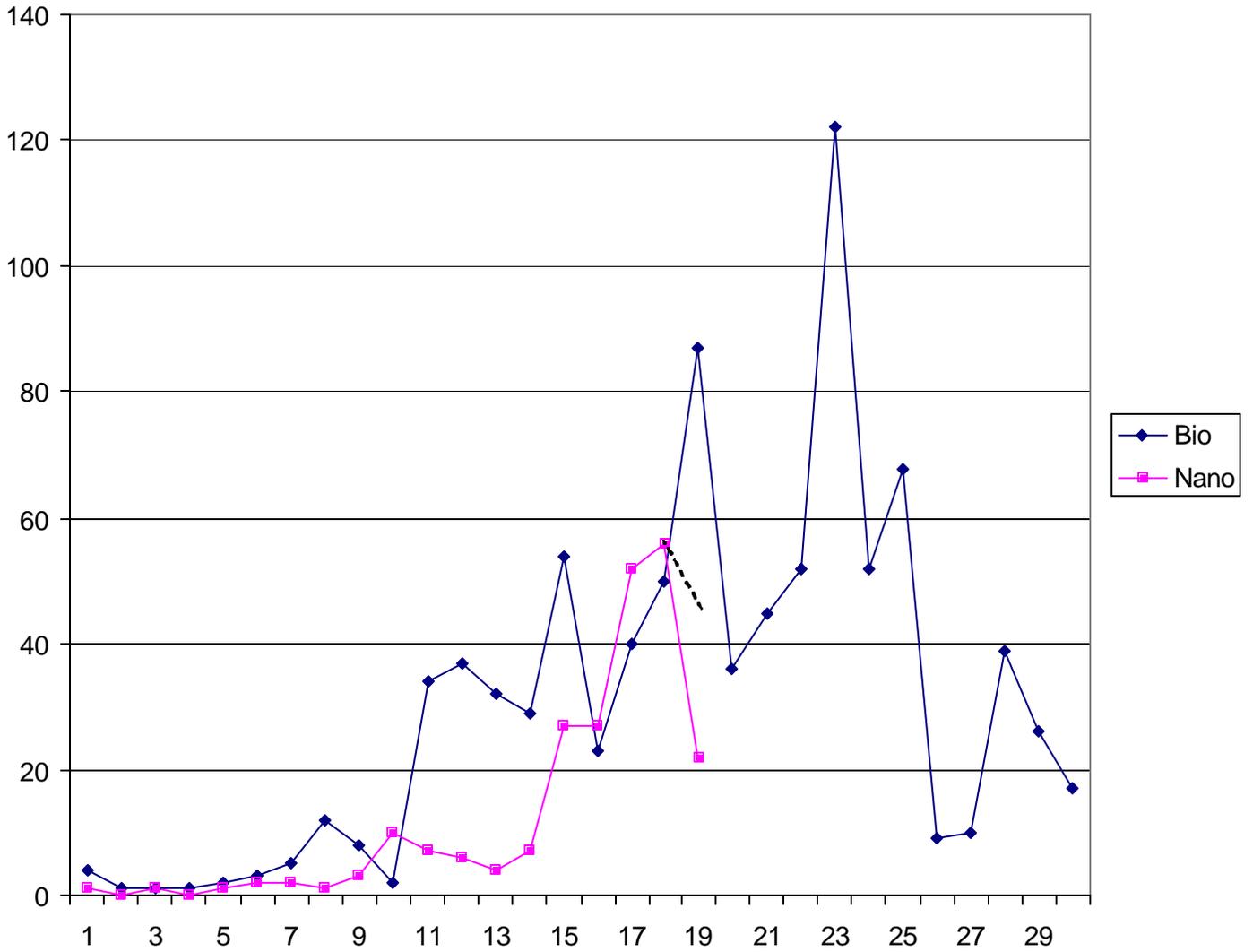


Figure 3. Comparison of biotechnology and nanotechnology coverage in the *New York Times*, with nanotechnology data shifted two years to the left.

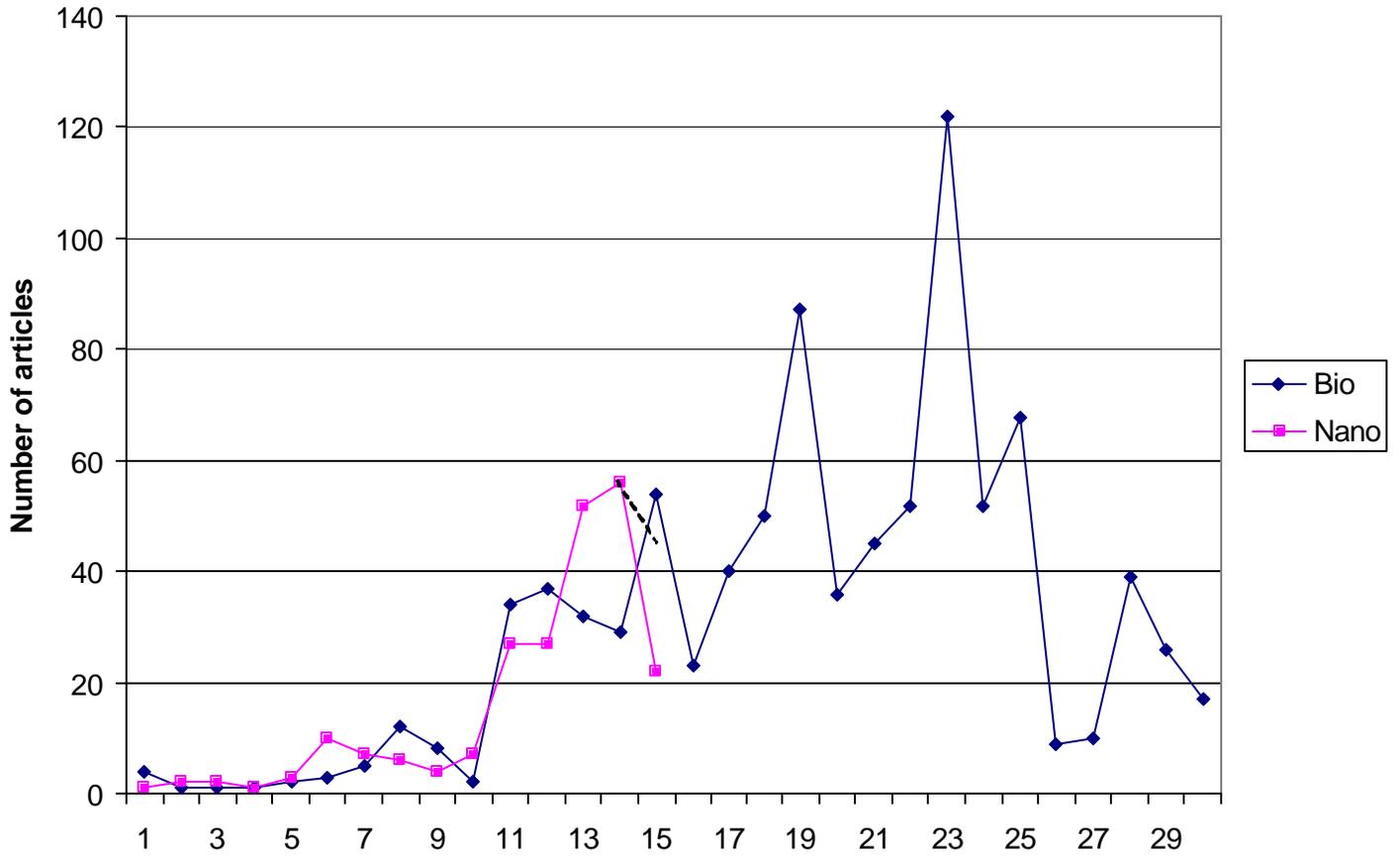
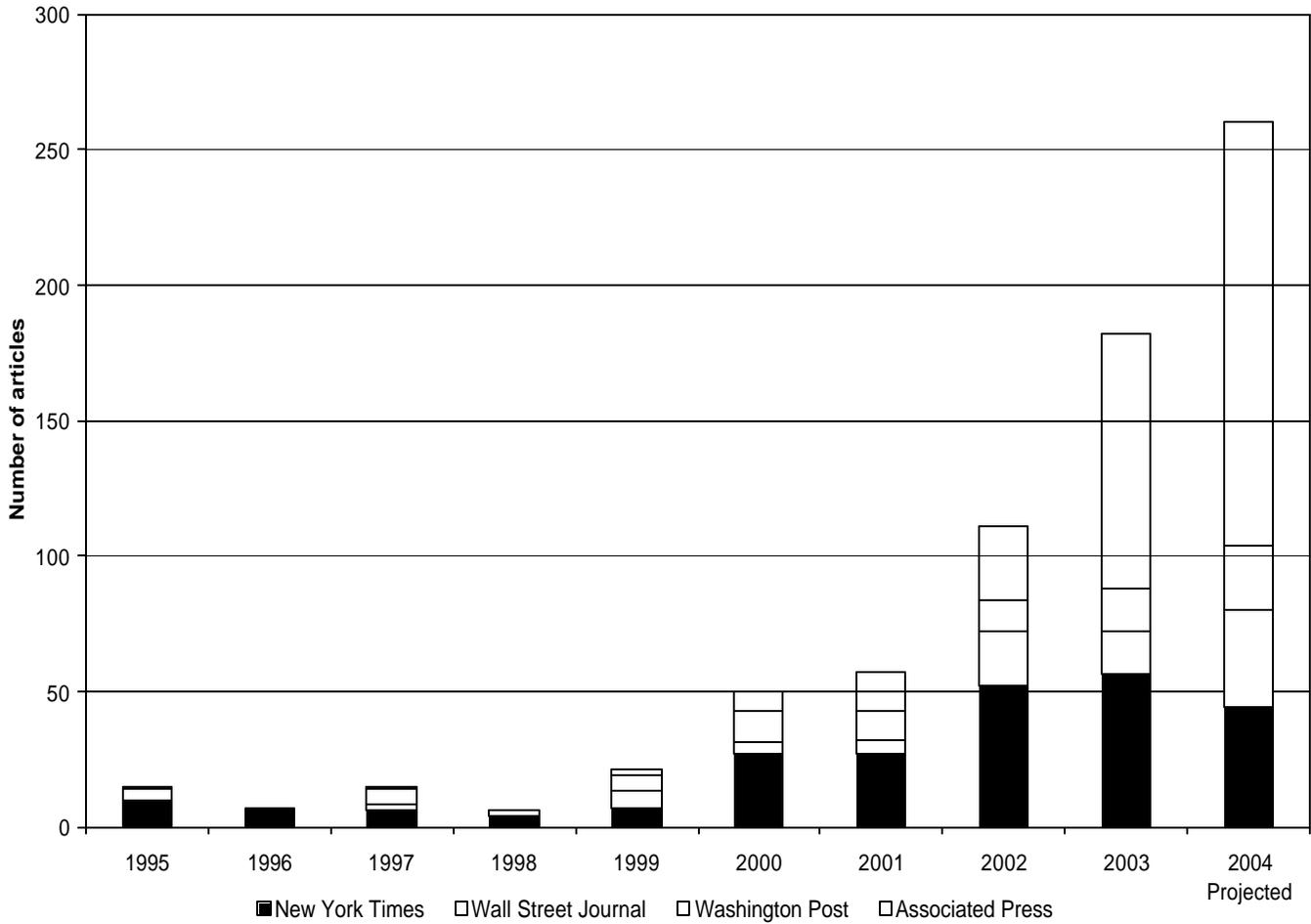


Figure 4. Media coverage by publication beginning in 1995 and including the projected value for 2004.



NOTE: The values for 2004 have simply been doubled to illustrate the projected value. No statistical inference was done to obtain these numbers.

Figure 5. Proportion of stories with positive and negative assessments over time.

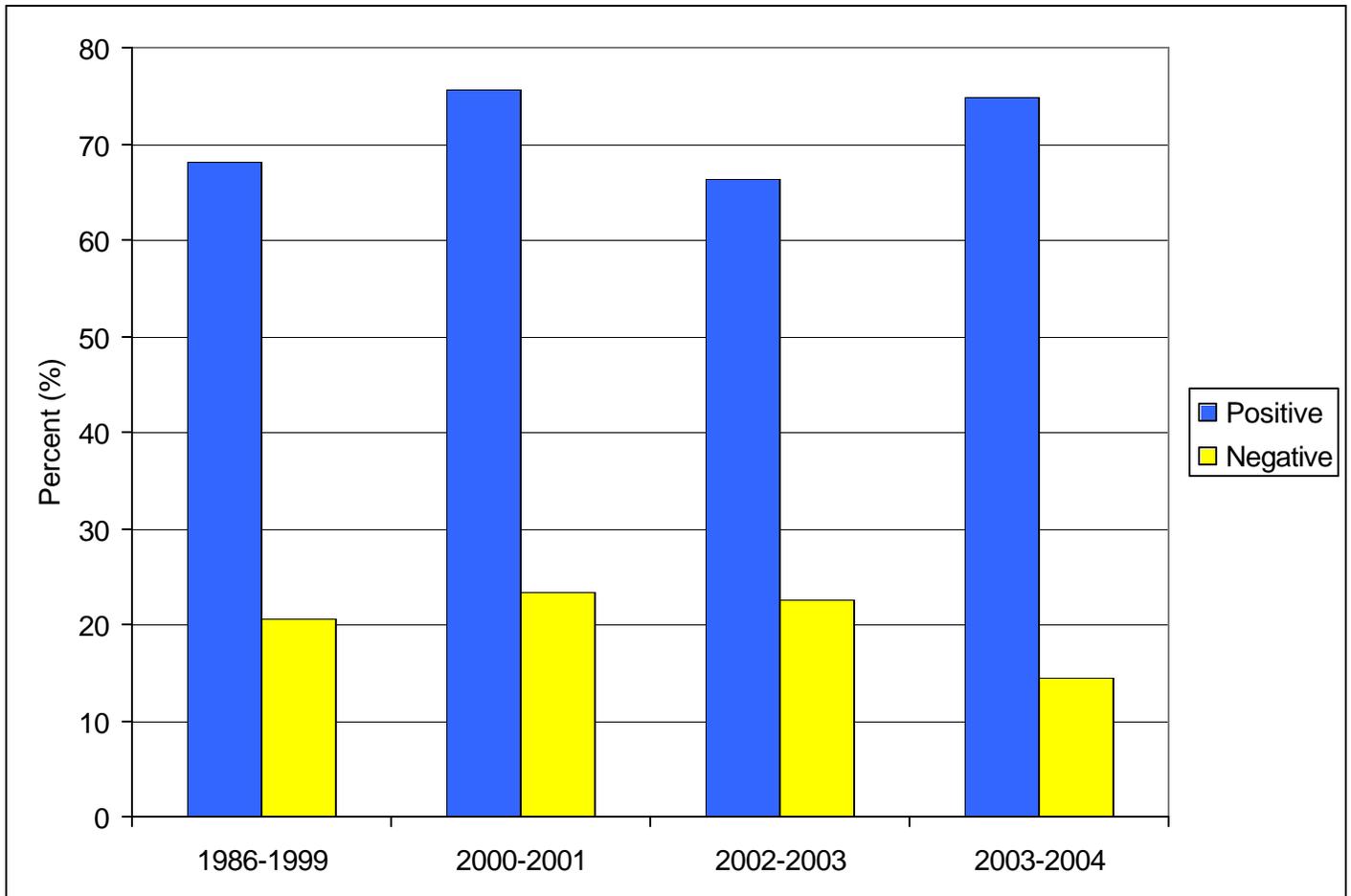


Figure 6. Stories containing positive assessments by theme.

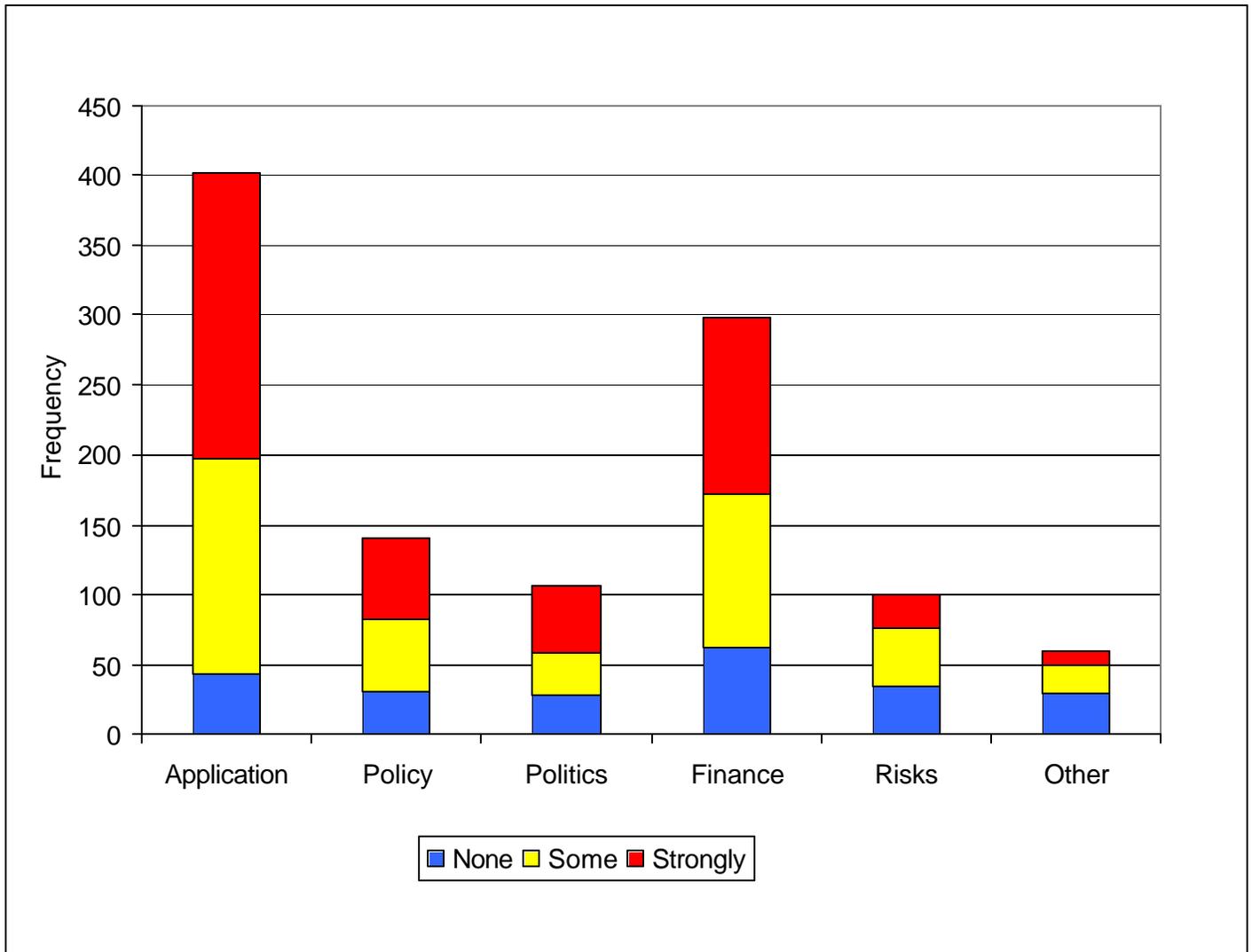


Figure 7. Stories containing negative assessments by theme.

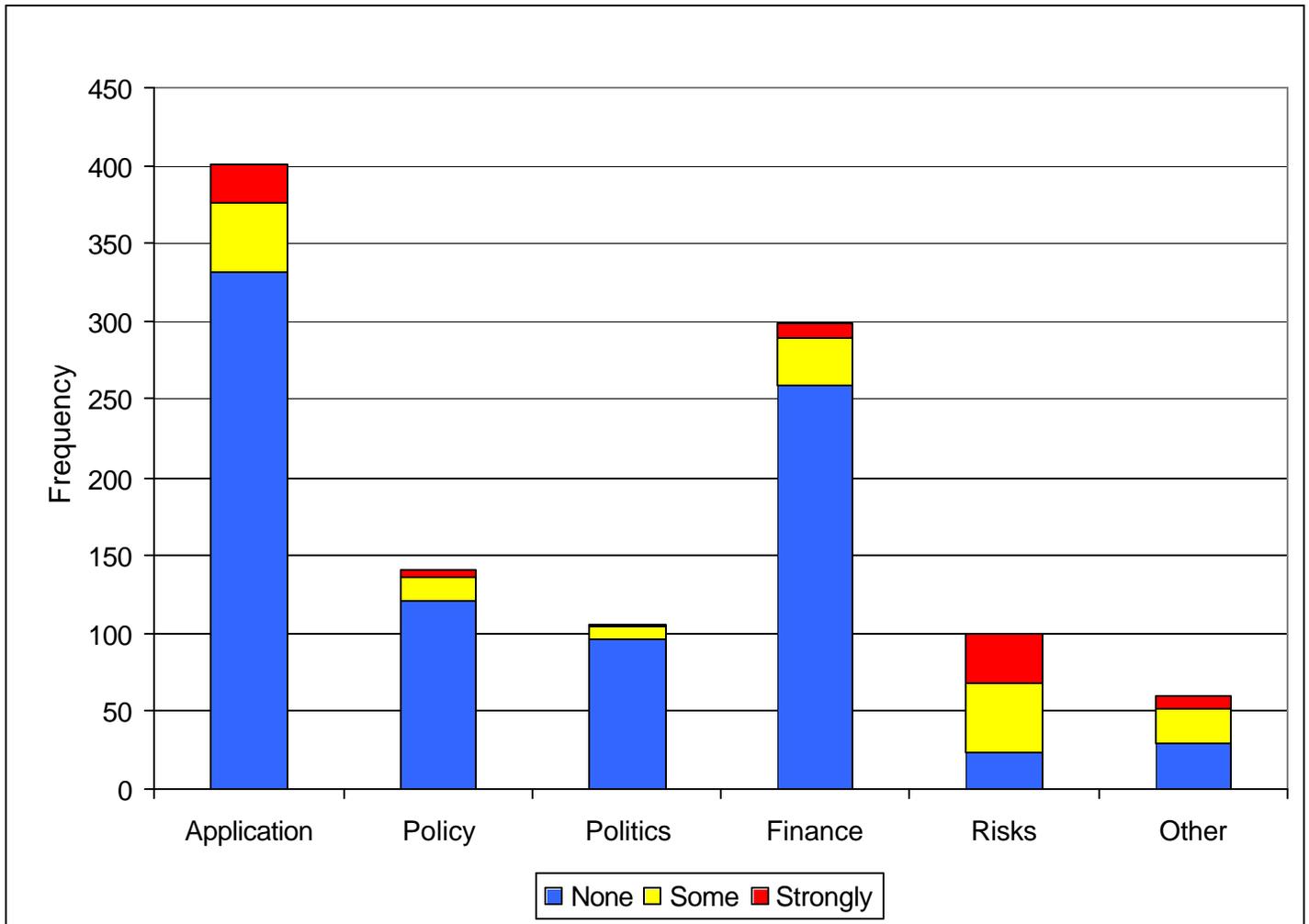


Figure 8. Percentage of stories by dominant frame.

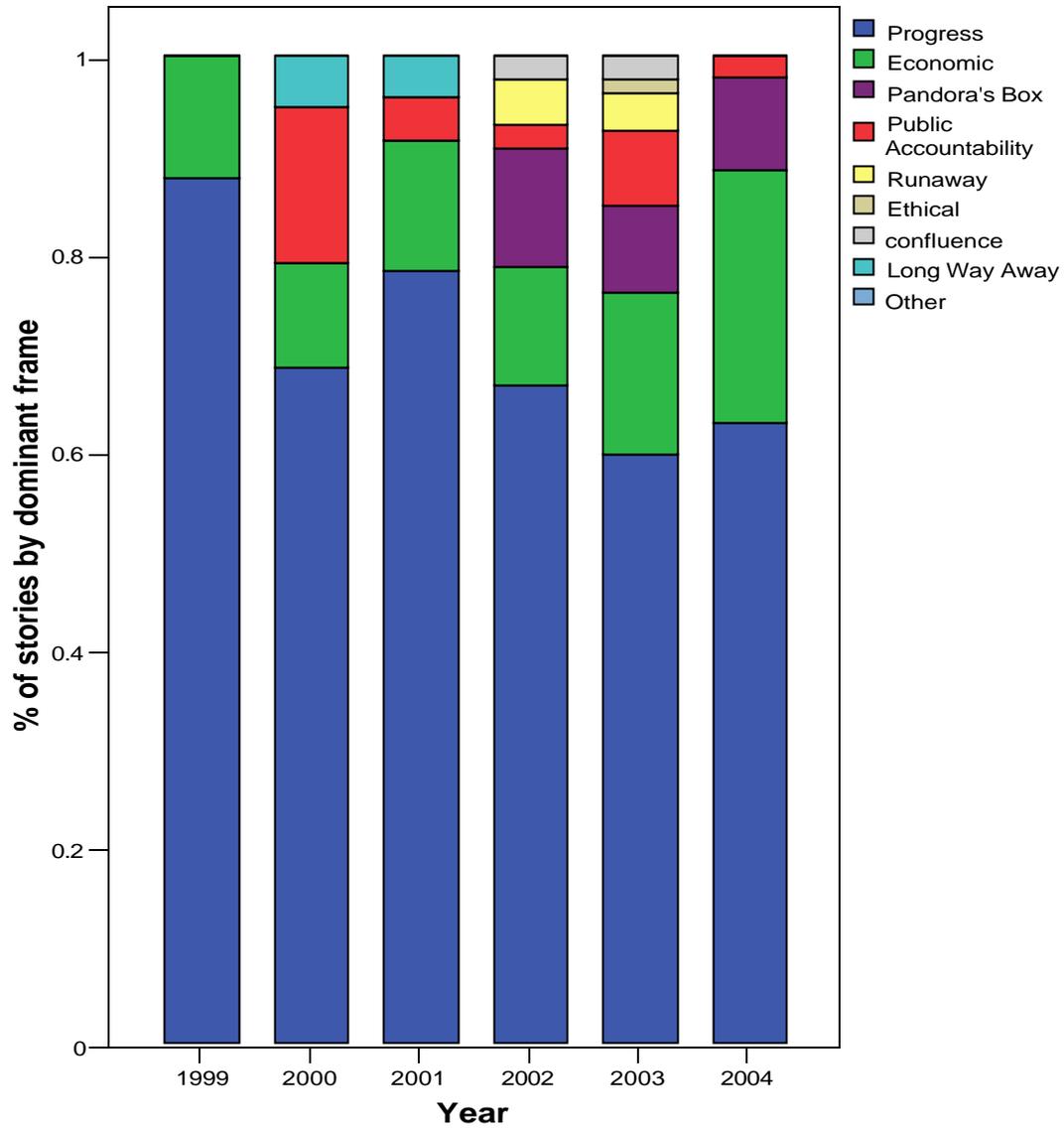


Figure 9. Positive assessments by frame.

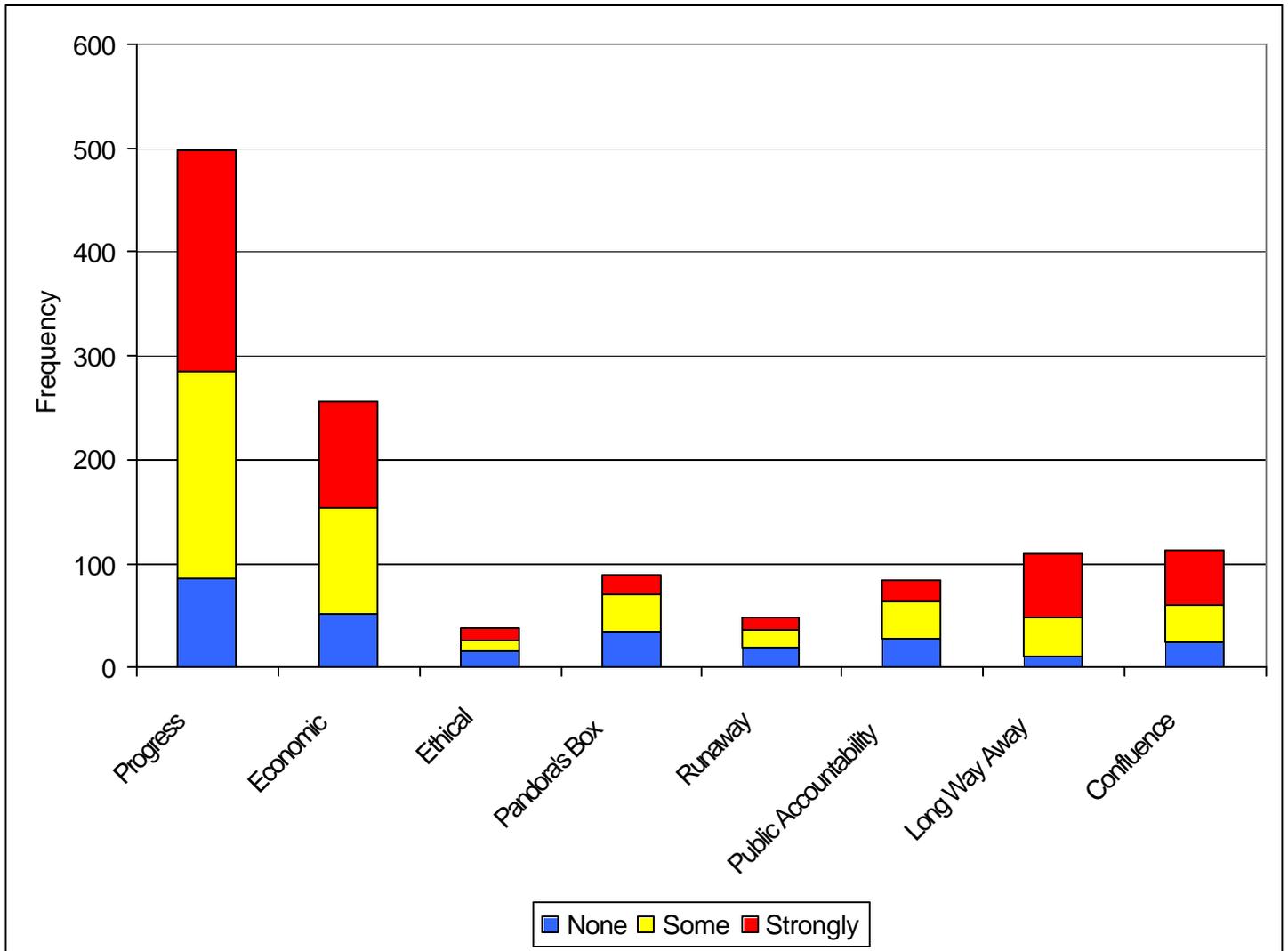


Figure 10. Negative assessments by frame.

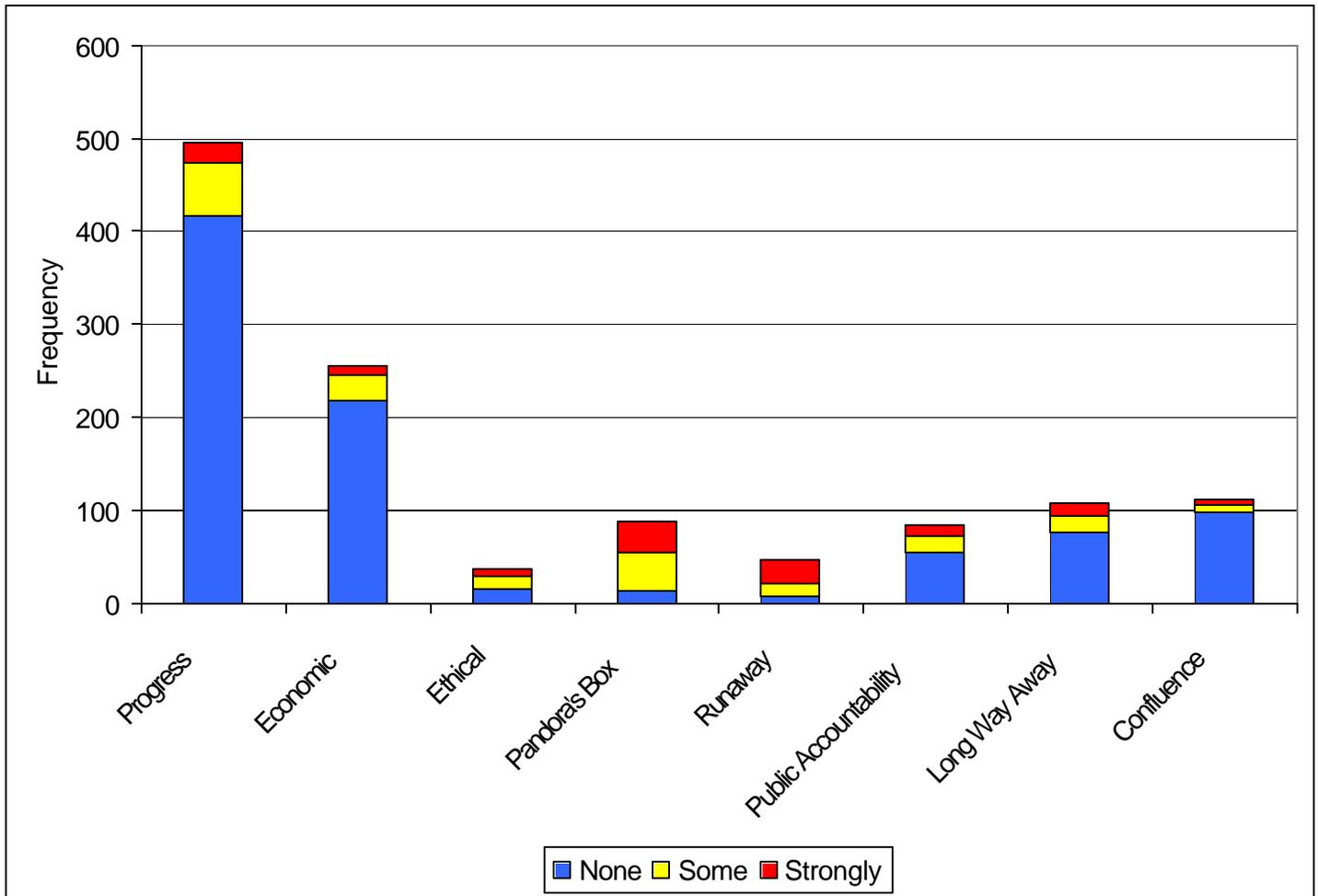


Figure 11. Frames for biotechnology and nanotechnology in the New York Times (first 20 years of biotechnology coverage).

